Load Responsive MLI: Thermal Insulation with High In-Atmosphere and On-Orbit Performance, Phase II

Completed Technology Project (2009 - 2012)

Project Introduction

Lightweight, high performance thermal insulation is critical to NASA's next generation Exploration spacecraft. Zero or low cryogenic propellant boiloff is required during extended missions and lengthy on-orbit times. Heat flow through multilayer insulation is usually the largest heat leak in cryogenic systems, so improvements are desirable. Load Responsive Multi-Layer Insulation (LRMLI) is an innovative new technology using micro-molded polymer dynamic spacers that provide high performance insulation both in-atmosphere and on-orbit. LRMLI under atmospheric pressure compresses dynamic spacers to support an integrated, thin vacuum shell for high performance in-atmosphere operation, and disconnects the spacers during on-orbit/lunar surface operation to reduce heat leak and provide ultra-high performance thermal insulation. LRMLI was successfully proven feasible in Phase I work, reaching TRL4. A LRMLI prototype was built and tested and a 3-layer, 0.25" thick blanket demonstrated 7.1 W/m2 (0.19 mW/m-K) heat leak for on-orbit and 14.3 W/m2 (0.34 mW/m-K) for in-atmosphere operation. Equal heat leak on-orbit of a 0.25" LRMLI blanket (2.1 kg/m2) would require 16" of SOFI (15 kg/m2), with LRMLI having a 64X advantage in thickness and a 7X advantage in mass. LRMLI insulation can provide superior cryogen insulation during ground hold, launch and on-orbit/vacuum conditions without need for purge. Total heat gain into cryogenic systems could be substantially reduced. Terrestrial non-NASA applications include LH2 powered aircraft and cars in development. This proposal is to further develop LRMLI toward commercialization. Tasks proposed include a study of both NASA& non-NASA applications to select two for further optimization, next generation design of dynamic spacers and modular vacuum shells, and building and testing prototypes in realistic environments such as a 3' diameter cryotank similar to a selected use like NASA Altair or Boeing HALE tanks.

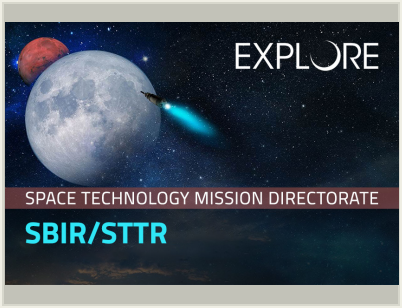

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Table of Contents

Load Responsive MLI: Thermal Insulation with High In-Atmosphere and On-Orbit Performance, Phase II

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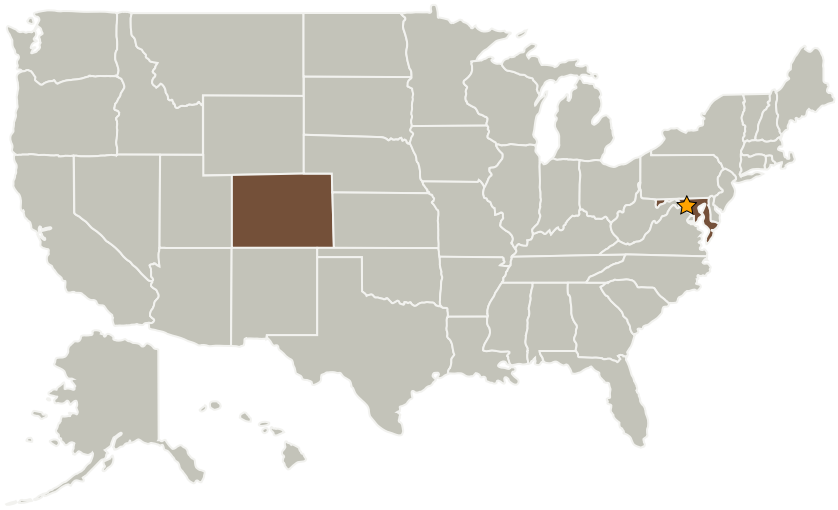
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Goddard Space Flight Center(GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland
Quest Product Development Corporation	Supporting Organization	Industry	Arvada, Colorado

Primary U.S. Work Locations	
Colorado	Maryland

Project Transitions

December 2009: Project Start

May 2012: Closed out

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Goddard Space Flight Center (GSFC)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Technology Areas

Primary:

- TX14 Thermal Management Systems
  - TX14.1 Cryogenic Systems
    - TX14.1.2 Launch Vehicle Propellant